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VOLUME I

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# BURST HEIGHT DISTRIBUTION COMPUTER MODEL

## VOLUME I. USER MANUAL

BOOZ, ALLEN APPLIED RESEARCH, INC.

TECHNICAL REPORT AFATL-TR-72-16, VOLUME I



JANUARY 1972



AIR FORCE ARMAMENT LABORATORY
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# Burst Height Distribution

# Computer Model

## Volume I User Manual

Donald E. Cudney

David O. Fraser

# FOREWORD

This report documents work accomplished during the period 18 January 1971 through 17 January 1972 by Booz, Allen Applied Research, Inc., P.O. Box 1797, Eglin Air Force Base, Florida, under Contract F08635-71-C-0093 with the U.S. Air Force Armament Laboratory, Eglin Air Force Base, Florida. The program monitors for the Armament Laboratory were Mr. Dan McInnis (DLYW) and Mr. Jerry Bass (DLYW).

The report consists of two volumes. Volume I, the User Manual, contains a detailed description of the input variables, instructions for placing the input variables on punch cards, instructions for arranging the punch cards in proper order, descriptions and definitions of the program output, a description of a sample case which can be used to verify that the program is operating properly, and a checklist of input data required to make up a test case. Volume II, the Analyst Manual, contains the mathematical relationships which were used to develop the model, the assumptions employed in constructing the model, flowcharts depicting the logical structure of the model, a listing of the source deck, and a detailed description of the simulation model based on the coding language employed and including comments identifying algebraic expressions which appear in the mathematical model.

The authors wish to acknowledge the assistance provided by several individuals in developing the methodology and computer program described in this report. Mr. Gary M. Grann of the U.S. Air Force Armament Laboratory was instrumental in developing the initial methodology and computer program. Also, the suggestions and comments provided by the members of the Methodology and Evaluation Working Group of the Degradation Effects Program were extremely helpful in developing the computer program.

This technical report has been reviewed and is approved.

Thomas P Christie
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## ABSTRACT

The Burst Height Distribution (BHD) Program described in this report was designed to compute and display burst height distributions for munitions aerially delivered into forest environments. The program uses as input the source and terminal X, Y, and Z coordinates and the average diameters of branches surveyed at actual forested sites, and the munitions travel along straight-line trajectories which are randomly selected. Burst heights are computed for those trajectories which encounter branches large enough to detonate the munition, and after 400 trajectories are examined (100 from each of four azimuth angles), the cumulative burst height distribution for the munition and elevation angle is computed, printed, and optionally punched as output. The computer program was specifically designed for the Control Data Corporation 6600 computer system at Eglin Air Force Base, Florida.






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# SECTION I

# INTRODUCTION

The Burst Height Distribution (BHD) Program was designed to compute and display burst height distributions for munitions aerially delivered into forest environments. The computer program was written in FORTRAN IV and is presently operational on the Control Data Corporation 6600 computer system at Eglin Air Force Base, Florida.

The program uses as input the source and terminal X, Y, and Z coordinates and the average diameters of branches surveyed at actual forested sites. Because of the large number of branches included in the characterization of the forest environments, all of the branch coordinates and diameters cannot be read into the computer central processor at one time. An input tape must be prepared with the branch data segmented into layers. The branch data for the top layer are then read into the computer central processor, and the munition trajectories are examined for possible encounters with the branches. For those munition trajectories which pass through the top layer and do not result in a munition detonation, the coordinates of the exit point from the bottom or side of the layer are determined. If the munition trajectory exits the side of the layer, the trajectory is reentered into the layer at the same height. If the trajectory exits the bottom of the layer, the exit coordinates from the top layer are used as entry coordinates for the second layer. This process is repeated until all layers have been examined or until the munition detonates. The procedure permits determination of the munition/branch encounters for all of the munition trajectories by inputting the branch data into the central processor only one time.

The munitions travel along straight-line trajectories which are randomly selected. If an encounter between a branch and the munition body occurs, the program determines if the branch is large enough to cause the munition to detonate. If the branch is large enough, the burst height is calculated. If the branch is too small, the program next determines if the munition fuze encounters the branch. If the fuze encounters the branch, the burst height is calculated, and if the fuze does not encounter the branch, the trajectory is continued. After 100 trajectories are examined from each of four azimuth angles (i.e., 0, 90, 180, and 270 degrees) and from the elevation angle specified as input, the cumulative burst height distribution for the munition is computed, printed, and optionally punched as output.

This volume contains:

- A detailed description of the input variables required to properly execute the program.
- Instructions for placing the input variables on punch cards.
- Instructions for arranging the punch cards in proper order.
- Descriptions and definitions of the output available from the program.
- A description of a sample case which can be used to verify that the program is operating properly.

Detailed discussions of the simulation model and the mathematical relationships which were utilized to develop the model (including flowcharts and definitions of variables) are contained in Volume II, the Analyst Manual, of this report.

# SECTION II

# INPUT

## INPUT DESCRIPTION

Two forms of input data are required to properly execute the BHD Program. These consist of a binary tape containing the X, Y, and Z coordinates and the average diameters of the branches which describe the forest environment and punch cards which denote specific munition, environment, and delivery parameters and the print and punch options which are to be used for the case.

The format for the data stored on magnetic tape is shown in Table I. The tape is in unformatted binary form and is segmented into any number of layers with each layer containing the X, Y, and Z coordinates of the branch ends and the average diameters of the branches. Data for up to 1,500 branches are stored in each layer. The tape is arranged so that branch data for the top layer are first, followed by data for layers of decreasing height. At least one end of each branch must be in the first octant of the X-Y-Z coordinate system, and branches cannot be located using a negative Z coordinate. The first logical record for each layer consists of all 10 variables listed in Table I, and all subsequent logical records for the layer contain only BRANCH (6) and DIAM values.

Fourteen parameters which describe the case to be run are read in from punch cards, and any number of cases can be run so long as two cards are prepared for each case. The program recognizes no unique end-of-data card but terminates when the system end-of-file record is encountered. The data card formats are presented in Table II. The column entitled CARD is the punch card identification number and is not actually punched on the card. The column entitled VARIABLE denotes the parameter which is to be defined on the card, and the column entitled COLUMN refers to the field of the card in which the data values are to be entered. The column entitled FORMAT designates the format which must be used for punching the data values in the cards, and the column entitled DESCRIPTION contains a brief explanation or definition of the variable. Finally, the column entitled UNITS designates the unit of measurement that must be used for the variable.

TABLE I. MAGNETIC TAPE FORMAT

| VARIABLE | DESCRIPTION | UNITS |
|---|---|---|
| LEVEL | A sequential number which identifies the layers of branch input data (i.e., 1 identifies data for the top layer, 2 identifies data for the next layer from the top, etc.). | none |
| NBRAN | The number of branches described in the layer. | none |
| BOTTOM | The Z coordinate of the bottom of the layer. | mm |
| BRANCH(6) | An array describing the X, Y, and Z coordinates of the two branch ends. The first three locations contain the X, Y, and Z coordinates of the source end of the branch, and the last three locations contain the X, Y, and Z coordinates of the terminal end of the branch. | mm |
| DIAM | The average diameter of the branch. | mm |

TABLE II. DATA CARD FORMATS

| CARD | VARIABLE | COLUMN | FORMAT | DESCRIPTION | UNITS |
|---|---|---|---|---|---|
| 1 | PHI | 1 - 10 | F10.0 | The elevation angle for the trajectory paths. | degrees |
| | XLIMIT | 11 - 20 | F10.0 | The X coordinate which defines a boundary of the forest environment. | mm |
| | YLIMIT | 21 - 30 | F10.0 | The Y coordinate which defines a boundary of the forest environment. | mm |
| | ZLIMIT | 31 - 40 | F10.0 | The Z coordinate which defines a boundary of the forest environment. | mm |
| | DUMMY | 41 - 50 | F10.0 | The random number generator starting value. | none |
| | XINT | 51 - 60 | F10.0 | The burst height interval. | feet |
| | IPUNCH | 61 - 62 | I2 | The punch option:<br>0 = do not punch cards.<br>1 = punch cards for the burst height intervals, the number of detonations in each interval, and the cumulative frequency for each interval. | none |
| | IPRINT | 63 - 64 | I2 | The print option:<br>0 = print the burst height and branch diameter for each detonation and the burst height distribution table.<br>1 = print the burst height distribution table. | none |

TABLE II. (CONCLUDED)

| CARD | VARIABLE | COLUMN | FORMAT | DESCRIPTION | UNITS |
|---|---|---|---|---|---|
| 2 | BDIAM | 1 - 10 | F10.0 | The diameter of the munition body. | mm |
| | FDIAM | 11 - 20 | F10.0 | The diameter of the munition fuze. | mm |
| | BBDIAM | 21 - 30 | F10.0 | The minimum branch diameter required for detonation by the munition body. | mm |
| | BFDIAM | 31 - 40 | F10.0 | The minimum branch diameter required for detonation by the munition fuze. | mm |
| | NMUN | 51 - 55 | I5 | The munition identification number. | none |
| | SITE | 56 - 65 | A10 | The identifying notation for the forest environment. | none |

## DATA DECK SETUP

Figure 1 depicts the order in which the data cards must be arranged to insure proper execution of the simulation.

## PROGRAM DECK SETUP

Figure 2 displays the program deck setup that must be used to properly execute the BHD Program on the Control Data Corporation 6600 computer system at Eglin Air Force Base, Florida.

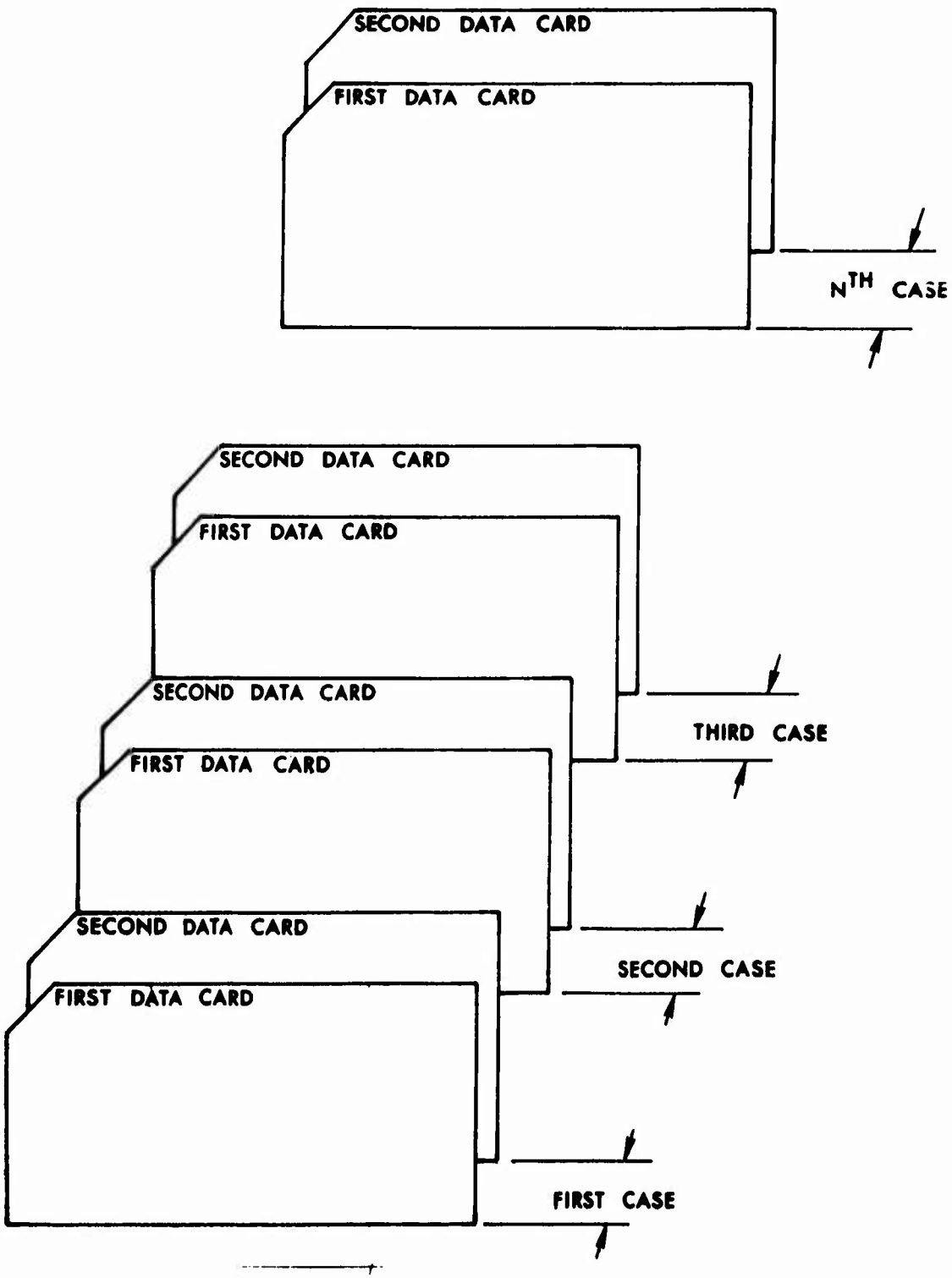


Figure 1. Typical Data Deck Setup

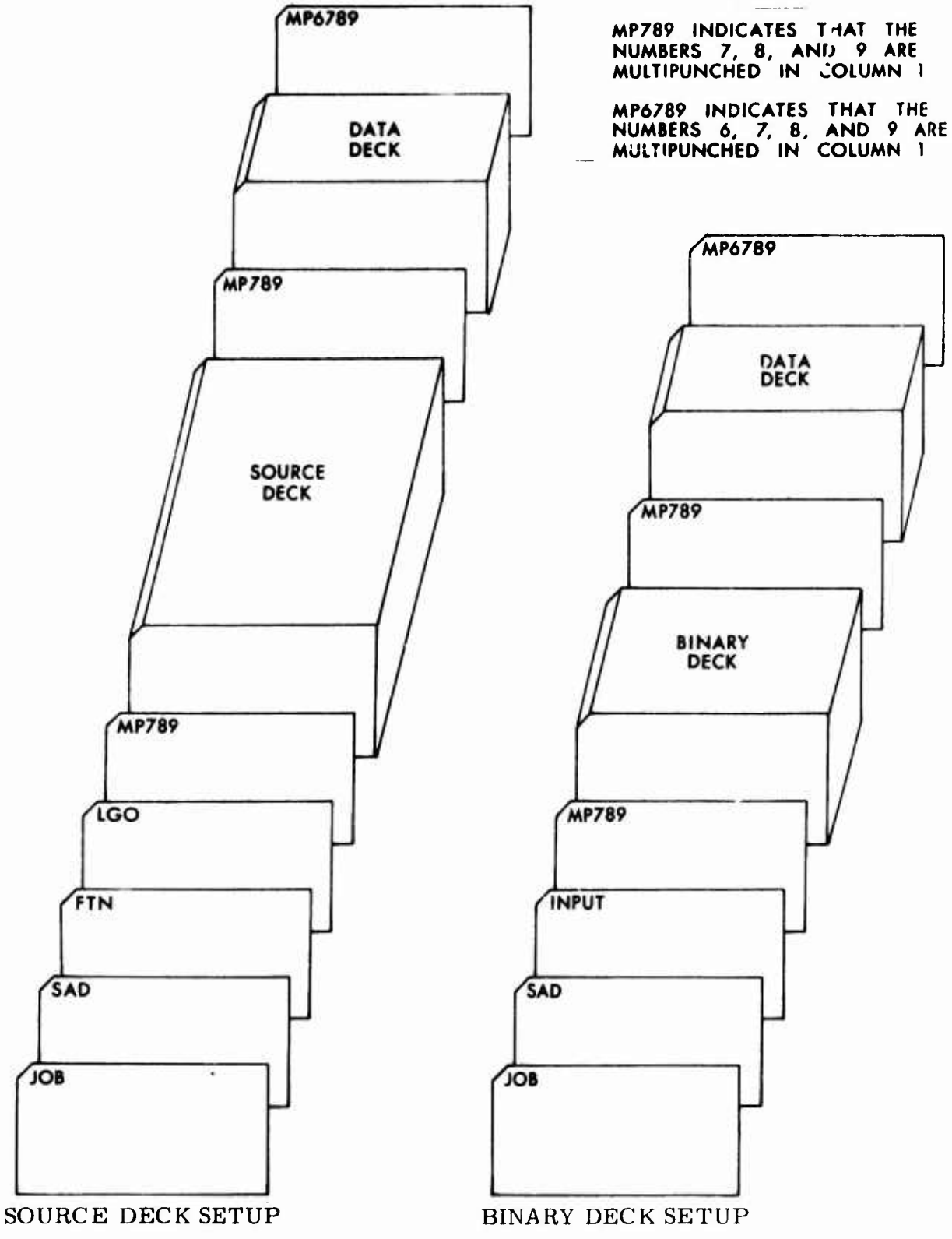


Figure 2. Program Deck Setup - Control Data Corporation 6600 Computer System

## SECTION III

## OUTPUT

The computer program output is available in printed and/or punched form. The normal printout is obtained when the value of the input variable IPRINT is set to 0. This output consists of case identifying information, the burst height and branch diameter for each munition detonation above the ground, and the burst height distribution table. When IPRINT is set to 1, only the case identifying information and the burst height distribution table are printed. The punch card output is obtained when the value of the input variable IPUNCH is set to 1. This output consists of case identifying information and the burst height distribution table. No punch card output is produced if IPUNCH is set to 0.

### OUTPUT NOMENCLATURE

The nomenclature for the printed output is self-explanatory, and the nomenclature for the punch card output is presented in Table III.

### SAMPLE OUTPUT

Sample output for one case is presented in Figures 3, 4, and 5. Figure 3 shows a sample printout which is obtained when IPRINT is set to 0, Figure 4 shows a sample printout which is obtained when IPRINT is set to 1, and Figure 5 presents the punch card output obtained when IPUNCH is set to 1.

TABLE III. PUNCH CARD OUTPUT NOMENCLATURE

| CARD | COLUMN | DESCRIPTION | UNITS |
|---|---|---|---|
| 1 | 5 - 14 | The identifying notation for the forest environment. | none |
| | 35 - 39 | The munition identification number. | none |
| | 60 - 66 | The elevation angle for the munition trajectory paths. | degrees |
| 2 | 21 - 30 | The number of ground bursts. | none |
| | 31 - 40 | The percentage of detonations which were ground bursts. | percent |
| 3, 4, . . . . , N | 1 - 10 | The lower boundary of the burst height interval. | feet |
| | 11 - 20 | The upper boundary of the burst height interval. | feet |
| | 21 - 30 | The number of munition detonations for the burst height interval. | none |
| | 31 - 40 | The cumulative percentage of detonations for the burst height interval. | percent |

SITE P2-08

MUNITION NUMBER = 2

MUNITION BODY DIAMETER = 75.00 MILLIMETERS ELEVATION ANGLE = 60. DEGREES

MUNITION FUZE DIAMETER = 0.00 MILLIMETERS AZIMUTH ANGLE = 0. DEGREES

RANDOM NO. SEED = 65.43

MINIMUM BRANCH DIAMETER REQUIRED FOR DETONATION GIVEN BODY HIT = 3000.00 MILLIMETERS

MINIMUM BRANCH DIAMETER REQUIRED FOR DETONATION GIVEN FUZE HIT = 5.00 MILLIMETERS

| BURST HEIGHT (FT.) | BRANCH DIAMETER (MM.) |
|---|---|
| 11.88 | 58.00 |
| 7.12 | 26.00 |
| 7.90 | 8.00 |
| 9.12 | 8.00 |
| 11.28 | 19.00 |
| 9.40 | 20.00 |
| 7.26 | 9.00 |
| 17.82 | 40.00 |
| 7.82 | 18.00 |
| 9.43 | 19.00 |
| 12.78 | 18.00 |
| 11.99 | 58.00 |
| 17.15 | 10.00 |
| 6.28 | 9.00 |
| 5.96 | 9.00 |
| 5.98 | 20.00 |
| 4.90 | 56.00 |
| 5.09 | 11.00 |
| 4.83 | 6.00 |
| 3.86 | 6.00 |
| 3.18 | 10.00 |
| 2.37 | 9.00 |
| 2.32 | 9.00 |
| 1,19 | 21.00 |

THERE WERE ALSO 76 GROUND BURSTS.

MEAN BURST HEIGHT = 1.87 FEET

VARIANCE = 15.6212

STANDARD DEVIATION = 3.95 FEET

Figure 3. Sample Output for Printout Option IPRINT = 0

SITE P2-08

MUNITION NUMBER = 2

MUNITION BODY DIAMETER = 75.00 MILLIMETERS
ELEVATION ANGLE = 60. DEGREES

MUNITION FUZE DIAMETER = 0.00 MILLIMETERS
AZIMUTH ANGLE = 90. DEGREES

RANDOM NO. SEED = 66.43

MINIMUM BRANCH DIAMETER REQUIRED FOR DETONATION GIVEN BODY HIT = 3000.00 MILLIMETERS

MINIMUM BRANCH DIAMETER REQUIRED FOR DETONATION GIVEN FUZE HIT = 5.00 MILLIMETERS

| BURST HEIGHT (FT.) | BRANCH DIAMETER (MM.) |
|---|---|
| 7.43 | 23.00 |
| 9.14 | 19.00 |
| 7.90 | 7.00 |
| 10.91 | 19.00 |
| 7.16 | 75.00 |
| 10.26 | 75.00 |
| 7.44 | 44.00 |
| 6.20 | 9.00 |
| 4.43 | 56.00 |
| 4.09 | 18.00 |
| 3.29 | 18.00 |
| 2.64 | 18.00 |
| 2.51 | 11.00 |
| 1.69 | 21.00 |
| .84 | 21.00 |
| 1.38 | 21.00 |
| 1.65 | 6.00 |
| 2.04 | 8.00 |

THERE WERE ALSO 82 GROUND BURSTS.

MEAN BURST HEIGHT = .91 FEET
VARIANCE = 5.6621
STANDARD DEVIATION = 2.38 FEET

Figure 3. (Continued)

SITE P2-08

MUNITION NUMBER = 2

MUNITION BODY DIAMETER = 75.00 MILLIMETERS

MUNITION FUZE DIAMETER = 0.00 MILLIMETERS

ELEVATION ANGLE = 60. DEGREES

AZIMUTH ANGLE = 180. DEGREES

RANDOM NO. SEED = 67.43

MINIMUM BRANCH DIAMETER REQUIRED FOR DETONATION GIVEN BODY HIT = 3000.00 MILLIMETERS

MINIMUM BRANCH DIAMETER REQUIRED FOR DETONATION GIVEN FUZE HIT = 5.00 MILLIMETERS

| BURST HEIGHT (FT.) | BRANCH DIAMETER (MM.) |
|---|---|
| 9.88 | 19.00 |
| 11.05 | 75.00 |
| 11.24 | 19.00 |
| 7.31 | 23.00 |
| 9.68 | 75.00 |
| 7.43 | 23.00 |
| 8.91 | 75.00 |
| 10.97 | 13.00 |
| 14.89 | 10.00 |
| 16.90 | 40.00 |
| 6.30 | 8.00 |
| 4.56 | 39.00 |
| 3.67 | 9.00 |
| 3.24 | 21.00 |
| 3.15 | 7.00 |
| 3.02 | 11.00 |
| 2.26 | 21.00 |
| 2.05 | 21.00 |
| 2.01 | 13.00 |
| 1.92 | 19.00 |
| 1.32 | 21.00 |
| 1.55 | 18.00 |
| 1.30 | 39.00 |

THERE WERE ALSO 77 GROUND BURSTS.

MEAN BURST HEIGHT = 1.45 FEET

VARIANCE = 11.8463

STANDARD DEVIATION = 3.44 FEET

**Figure 3. (Continued)**

SITE P2-08

MUNITION NUMBER = 2

MUNITION BODY DIAMETER = 75.00 MILLIMETERS ELEVATION ANGLE = 60. DEGREES

MUNITION FUZE DIAMETER = 0.00 MILLIMETERS AZIMUTH ANGLE = 270. DEGREES

RANDOM NO. SEED = 68.43

MINIMUM BRANCH DIAMETER REQUIRED FOR DETONATION GIVEN BODY HIT = 3000.00 MILLIMETERS

MINIMUM BRANCH DIAMETER REQUIRED FOR DETONATION GIVEN FUZE HIT = 5.00 MILLIMETERS

| BURST HEIGHT (FT.) | BRANCH DIAMETER (MM.) |
|---|---|
| 9.85 | 13.00 |
| 10.63 | 8.00 |
| 10.23 | 19.00 |
| 19.46 | 8.00 |
| 7.95 | 20.00 |
| 7.89 | 44.00 |
| 10.74 | 13.00 |
| 16.24 | 40.00 |
| 6.14 | 26.00 |
| 6.13 | 6.00 |
| 5.75 | 11.00 |
| 5.95 | 10.00 |
| 5.50 | 11.00 |
| 4.72 | 7.00 |
| 4.96 | 12.00 |
| 4.99 | 11.00 |
| 5.02 | 6.00 |
| 4.11 | 18.00 |
| 3.43 | 75.00 |
| 3.01 | 21.00 |
| 2.88 | 11.00 |
| .81 | 21.00 |
| 1.76 | 21.00 |
| .97 | 18.00 |
| 2.07 | 8.00 |
| .81 | 21.00 |
| .79 | 75.00 |
| .79 | 75.00 |
| 1.61 | 39.00 |
| 1.97 | 21.00 |
| 2.10 | 21.00 |

THERE WERE ALSO 69 GROUND BURSTS.

MEAN BURST HEIGHT = 1.69 FEET

VARIANCE = 12.6257

STANDARD DEVIATION = 3.55 FEET

**Figure 3. (Continued)**

| INTERVAL FROM | INTERVAL TO | NO. OF DETONATIONS | CUMULATIVE PERCENTAGE |
|---|---|---|---|
| GROUND | BURSTS | 304 | 76.00 |
| .01 | 1.00 | 6 | 77.50 |
| 1.01 | 2.00 | 11 | 80.25 |
| 2.01 | 3.00 | 11 | 83.00 |
| 3.01 | 4.00 | 9 | 85.25 |
| 4.01 | 5.00 | 9 | 87.50 |
| 5.01 | 6.00 | 7 | 89.25 |
| 6.01 | 7.00 | 5 | 90.50 |
| 7.01 | 8.00 | 14 | 93.50 |
| 8.01 | 9.00 | 1 | 93.75 |
| 9.01 | 10.00 | 7 | 95.50 |
| 10.01 | 11.00 | 6 | 97.00 |
| 11.01 | 12.00 | 5 | 98.25 |
| 12.01 | 13.00 | 1 | 98.50 |
| 13.01 | 14.00 | 0 | 98.50 |
| 14.01 | 15.00 | 1 | 98.75 |
| 15.01 | 16.00 | 0 | 98.75 |
| 16.01 | 17.00 | 2 | 99.25 |
| 17.01 | 18.00 | 2 | 99.75 |
| 18.01 | 19.00 | 0 | 99.75 |
| 19.01 | 20.00 | 1 | 100.00 |

**Figure 3. (Concluded)**

SITE P2-08

MUNITION NUMBER = 2

MUNITION BODY DIAMETER = 75.00 MILLIMETERS ELEVATION ANGLE = 60. DEGREES

MUNITION FUZE DIAMETER = 0.00 MILLIMETERS AZIMUTH ANGLE = 0. DEGREES

RANDOM NO. SEED = 65.43

MINIMUM BRANCH DIAMETER REQUIRED FOR DETONATION GIVEN BODY HIT = 3000.00 MILLIMETERS

MINIMUM BRANCH DIAMETER REQUIRED FOR DETONATION GIVEN FUZE HIT = 5.00 MILLIMETERS

| INTERVAL FROM | INTERVAL TO | NO. OF DETONATIONS | CUMULATIVE PERCENTAGE |
|---|---|---|---|
| GROUND | BURSTS | 304 | 76.00 |
| .01 | 1.00 | 6 | 77.50 |
| 1.01 | 2.00 | 11 | 80.25 |
| 2.01 | 3.00 | 11 | 83.00 |
| 3.01 | 4.00 | 9 | 85.25 |
| 4.01 | 5.00 | 9 | 87.50 |
| 5.01 | 6.00 | 7 | 89.25 |
| 6.01 | 7.00 | 5 | 90.50 |
| 7.01 | 8.00 | 12 | 93.50 |
| 8.01 | 9.00 | 1 | 93.75 |
| 9.01 | 10.00 | 7 | 95.50 |
| 10.01 | 11.00 | 6 | 97.00 |
| 11.01 | 12.00 | 5 | 98.25 |
| 12.01 | 13.00 | 1 | 98.50 |
| 13.01 | 14.00 | 0 | 98.50 |
| 14.01 | 15.00 | 1 | 98.75 |
| 15.01 | 16.00 | 0 | 98.75 |
| 16.01 | 17.00 | 2 | 99.25 |
| 17.01 | 18.00 | 2 | 99.75 |
| 18.01 | 19.00 | 0 | 99.75 |
| 19.01 | 20.00 | 1 | 100.00 |

**Figure 4. Sample Output for Printout Option IPRINT = 1**

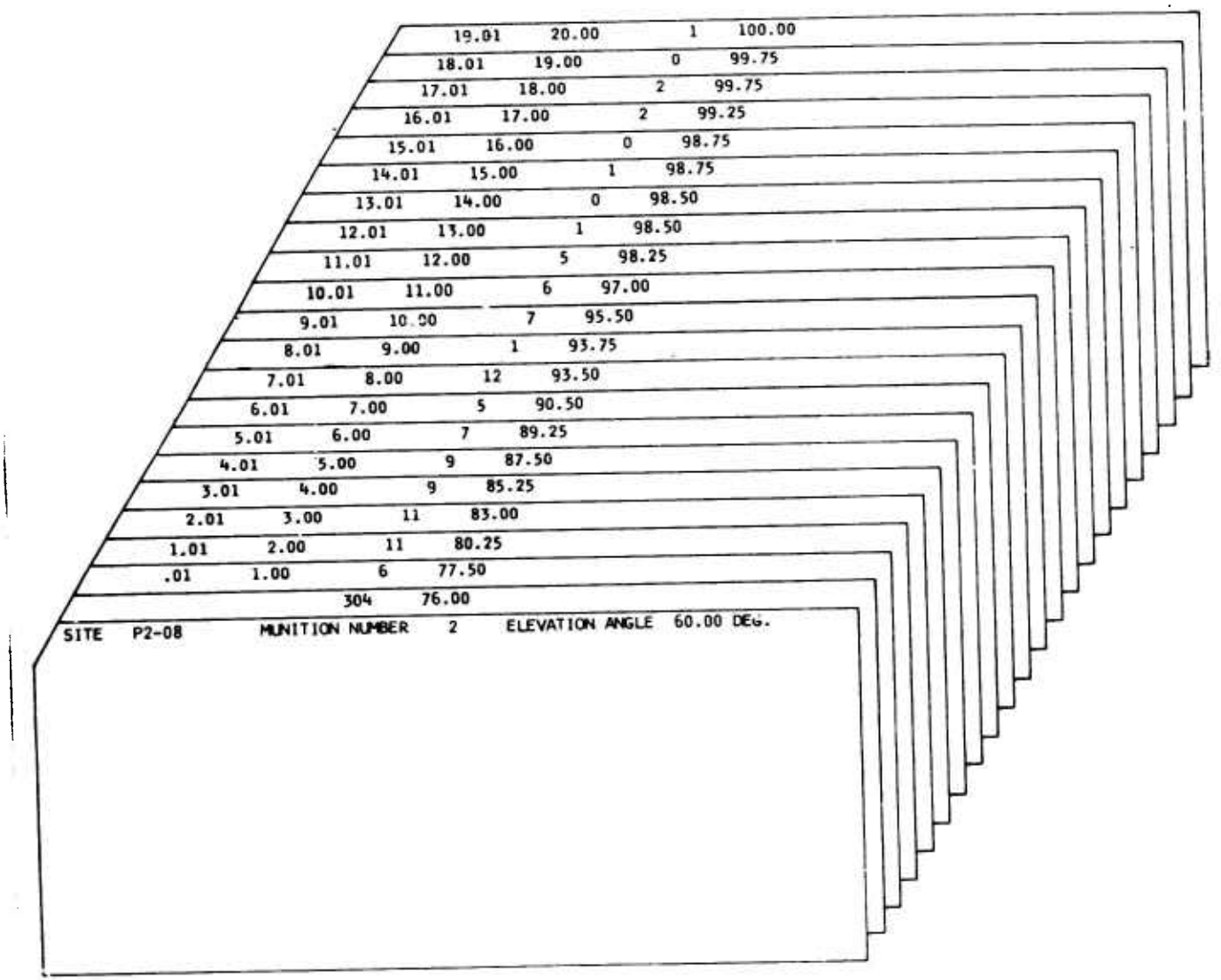


Figure 5. Sample Output for Punch Option IPUNCH = 1

## SECTION IV

## SAMPLE CASE

### DESCRIPTION OF CASE

For this particular sample case, the burst height distribution is to be determined in 1-foot intervals for a specific munition when delivered into a forest environment (Site P2-08) from a delivery angle of 60 degrees. The environment defined on magnetic tape is 7,000 millimeters long, 7,000 millimeters wide, and 7,000 millimeters high. The munition body diameter is 75.0 millimeters, and the effective munition fuze diameter is 0.0 millimeters (i.e., the munition will detonate only if the munition centerline encounters the branch). The munition will not detonate if the munition body encounters a branch, but it will detonate if a branch with a diameter of 5 millimeters or greater encounters the munition centerline. Detailed printout and punch cards are required as output. The values reflecting the above conditions and required as input to the program are given in Table IV.

### DATA DECK SETUP

Figure 6 shows the arrangement of the data cards that were used to run this sample case.

### SAMPLE CASE OUTPUT

Figure 7 shows the detailed printed output for the sample case, and Figure 8 shows the punch card output for the sample case.

TABLE IV. INPUT VALUES FOR SAMPLE CASE

| PARAMETER | VALUE | UNITS |
|---|---|---|
| PHI | 60. | degrees |
| XLIMIT | 7000. | mm |
| YLIMIT | 7000. | mm |
| ZLIMIT | 7000. | mm |
| DUMMY | 65.43 | none |
| XINT | 1.0 | feet |
| IPUNCH | 1 | none |
| IPRINT | 0 | none |
| BDIAM | 75. | mm |
| FDIAM | 0. | mm |
| BBDIAM | 3000. | mm |
| BFDIAM | 5. | mm |
| NMUN | 2 | none |
| SITE | P2-08 | none |

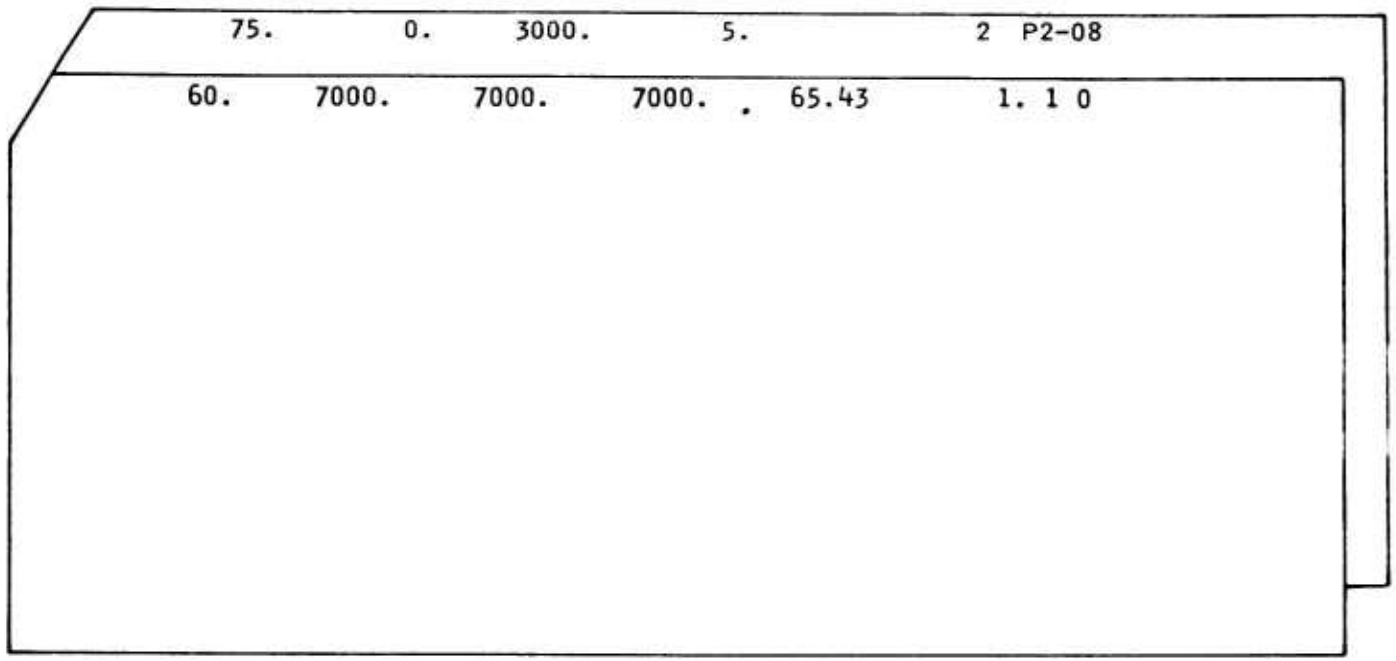


Figure 6. Sample Case Data Deck

SITE P2-08

MUNITION NUMBER = 2

MUNITION BODY DIAMETER = 75.00 MILLIMETERS ELEVATION ANGLE = 60. DEGREES

MUNITION FUZE DIAMETER = 0.00 MILLIMETERS AZIMUTH ANGLE = 0. DEGREES

RANDOM NO. SEED = 65.43

MINIMUM BRANCH DIAMETER REQUIRED FOR DETONATION GIVEN BODY HIT = 3000.00 MILLIMETERS

MINIMUM BRANCH DIAMETER REQUIRED FOR DETONATION GIVEN FUZE HIT = 5.00 MILLIMETERS

| BURST HEIGHT (FT.) | BRANCH DIAMETER (MM.) |
|---|---|
| 11.88 | 58.00 |
| 7.12 | 26.00 |
| 7.90 | 8.00 |
| 9.12 | 8.00 |
| 11.28 | 19.00 |
| 9.40 | 20.00 |
| 7.26 | 9.00 |
| 17.82 | 40.00 |
| 7.82 | 18.00 |
| 9.43 | 19.00 |
| 12.78 | 18.00 |
| 11.99 | 58.00 |
| 17.15 | 10.00 |
| 6.28 | 9.00 |
| 5.96 | 9.00 |
| 5.98 | 20.00 |
| 4.90 | 56.00 |
| 5.09 | 11.00 |
| 4.83 | 6.00 |
| 3.86 | 6.00 |
| 3.18 | 10.00 |
| 2.37 | 9.00 |
| 2.32 | 9.00 |
| 1.19 | 21.00 |

THERE WERE ALSO 76 GROUND BURSTS.

MEAN BURST HEIGHT = 1.87 FEET

VARIANCE = 15.6212

STANDARD DEVIATION = 3.95 FEET

**Figure 7. Sample Cast Output for IPRINT = 0**

SITE P2-08

MUNITION NUMBER = 2

MUNITION BODY DIAMETER = 75.00 MILLIMETERS
ELEVATION ANGLE = 60. DEGREES

MUNITION FUZE DIAMETER = 0.00 MILLIMETERS
AZIMUTH ANGLE = 90. DEGREES

RANDOM NO. SEED = 66.43

MINIMUM BRANCH DIAMETER REQUIRED FOR DETONATION GIVEN BODY HIT = 3000.00 MILLIMETERS

MINIMUM BRANCH DIAMETER REQUIRED FOR DETONATION GIVEN FUZE HIT = 5.00 MILLIMETERS

| BURST HEIGHT (FT.) | BRANCH DIAMETER (MM.) |
|---|---|
| 7.43 | 23.00 |
| 9.14 | 19.00 |
| 7.90 | 7.00 |
| 10.91 | 19.00 |
| 7.16 | 75.00 |
| 10.26 | 75.00 |
| 7.44 | 44.00 |
| 6.20 | 9.00 |
| 4.43 | 56.00 |
| 4.09 | 18.00 |
| 3.29 | 18.00 |
| 2.64 | 18.00 |
| 2.51 | 11.00 |
| 1.69 | 21.00 |
| .84 | 21.00 |
| 1.38 | 21.00 |
| 1.65 | 6.00 |
| 2.04 | 8.00 |

THERE WERE ALSO 82 GROUND BURSTS.

MEAN BURST HEIGHT = .91 FEET
VARIANCE = 5.6621
STANDARD DEVIATION = 2.38 FEET

**Figure 7. (Continued)**

SITE P2-08

MUNITION NUMBER = 2

MUNITION BODY DIAMETER = 75.00 MILLIMETERS
ELEVATION ANGLE = 60. DEGREES

MUNITION FUZE DIAMETER = 0.00 MILLIMETERS
AZIMUTH ANGLE = 180. DEGREES

RANDOM NO. SEED = 67.43

MINIMUM BRANCH DIAMETER REQUIRED FOR DETONATION GIVEN BODY HIT = 3000.00 MILLIMETERS

MINIMUM BRANCH DIAMETER REQUIRED FOR DETONATION GIVEN FUZE HIT = 5.00 MILLIMETERS

| BURST HEIGHT (FT.) | BRANCH DIAMETER (MM.) |
|---|---|
| 9.88 | 19.00 |
| 11.05 | 75.00 |
| 11.24 | 19.00 |
| 7.31 | 23.00 |
| 9.68 | 75.00 |
| 7.43 | 23.00 |
| 8.91 | 75.00 |
| 10.97 | 13.00 |
| 14.89 | 10.00 |
| 16.90 | 40.00 |
| 6.30 | 8.00 |
| 4.56 | 39.00 |
| 3.67 | 9.00 |
| 3.24 | 21.00 |
| 3.15 | 7.00 |
| 3.02 | 11.00 |
| 2.26 | 21.00 |
| 2.05 | 21.00 |
| 2.01 | 13.00 |
| 1.92 | 19.00 |
| 1.32 | 21.00 |
| 1.55 | 18.00 |
| 1.30 | 39.00 |

THERE WERE ALSO 77 GROUND BURSTS.

MEAN BURST HEIGHT = 1.45 FEET
VARIANCE = 11.8463
STANDARD DEVIATION = 3.44 FEET

Figure 7. (Continued)

SITE P2 08

MUNITION NUMBER = 2

MUNITION BODY DIAMETER = 75.00 MILLIMETERS
ELEVATION ANGLE = 60. DEGREES

MUNITION FUZE DIAMETER = 0.00 MILLIMETERS
AZIMUTH ANGLE = 270. DEGREES

RANDOM NO. SEED = 68.43

MINIMUM BRANCH DIAMETER REQUIRED FOR DETONATION GIVEN BODY HIT = 3000.00 MILLIMETERS

MINIMUM BRANCH DIAMETER REQUIRED FOR DETONATION GIVEN FUZE HIT = 5.00 MILLIMETERS

| BURST HEIGHT (FT.) | BRANCH DIAMETER (MM.) |
|---|---|
| 9.85 | 13.00 |
| 10.63 | 8.00 |
| 10.23 | 19.00 |
| 19.46 | 8.00 |
| 7.95 | 20.00 |
| 7.89 | 44.00 |
| 10.74 | 13.00 |
| 16.24 | 40.00 |
| 6.14 | 26.00 |
| 6.13 | 6.00 |
| 5.75 | 11.00 |
| 5.95 | 10.00 |
| 5.50 | 11.00 |
| 4.72 | 7.00 |
| 4.96 | 12.00 |
| 4.99 | 11.00 |
| 5.02 | 6.00 |
| 4.11 | 18.00 |
| 3.43 | 75.00 |
| 3.01 | 21.00 |
| 2.88 | 11.00 |
| .81 | 21.00 |
| 1.76 | 21.00 |
| .97 | 18.00 |
| 2.07 | 8.00 |
| .81 | 21.00 |
| .79 | 75.00 |
| .79 | 75.00 |
| 1.61 | 39.00 |
| 1.97 | 21.00 |
| 2.10 | 21.00 |

THERE WERE ALSO 69 GROUND BURSTS.

MEAN BURST HEIGHT = 1.69 FEET
VARIANCE = 12.6257
STANDARD DEVIATION = 3.55 FEET

Figure 7. (Continued)

| INTERVAL FROM | INTERVAL TO | NO. OF DETONATIONS | CUMULATIVE PERCENTAGE |
|---|---|---|---|
| GROUND | BURSTS | 304 | 76.00 |
| .01 | 1.00 | 6 | 77.50 |
| 1.01 | 2.00 | 11 | 80.25 |
| 2.01 | 3.00 | 11 | 83.00 |
| 3.01 | 4.00 | 9 | 85.25 |
| 4.01 | 5.00 | 9 | 87.50 |
| 5.01 | 6.00 | 7 | 89.25 |
| 6.01 | 7.00 | 5 | 90.50 |
| 7.01 | 8.00 | 12 | 93.50 |
| 8.01 | 9.00 | 1 | 93.75 |
| 9.01 | 10.00 | 7 | 95.50 |
| 10.01 | 11.00 | 6 | 97.00 |
| 11.01 | 12.00 | 5 | 98.25 |
| 12.01 | 13.00 | 1 | 98.50 |
| 13.01 | 14.00 | 0 | 98.50 |
| 14.01 | 15.00 | 1 | 98.75 |
| 15.01 | 16.00 | 0 | 98.75 |
| 16.01 | 17.00 | 2 | 99.25 |
| 17.01 | 18.00 | 2 | 99.75 |
| 18.01 | 19.00 | 0 | 99.75 |
| 19.01 | 20.00 | 1 | 100.00 |

**Figure 7. (Concluded)**

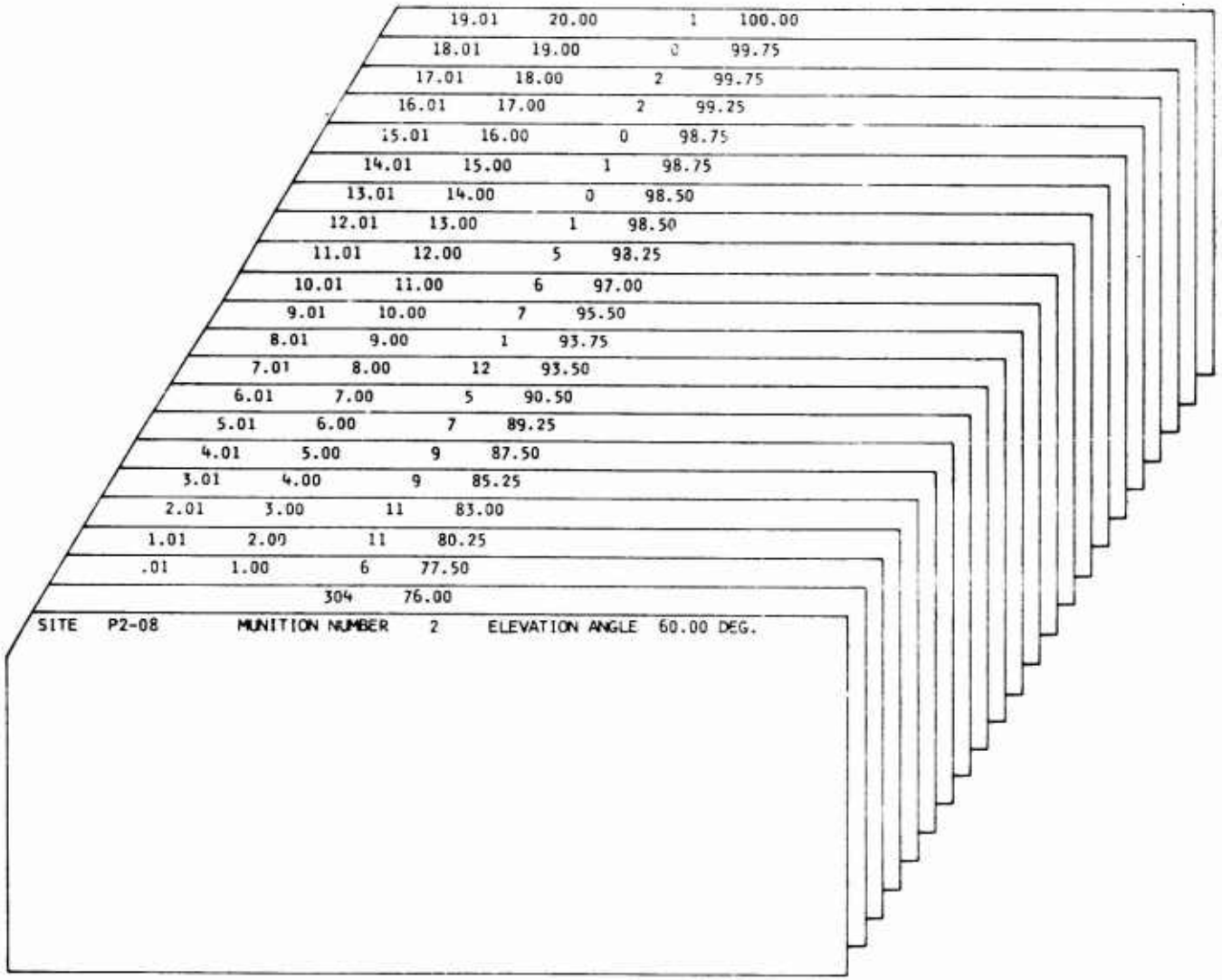


Figure 8. Sample Case Output for IPUNCH = 1

## APPENDIX

## DATA CHECKSHEET

| CARD | PAGE | PARAMETER | VALUE |
|---|---|---|---|
| 1 | 5 | PHI | 60. |
| | 5 | XLIMIT | 7000. |
| | 5 | YLIMIT | 7000. |
| | 5 | ZLIMIT | 7000. |
| | 5 | DUMMY | 65.43 |
| | 5 | XINT | 1.0 |
| | 5 | IPUNCH | 1 |
| | 5 | IPRINT | 0 |
| 2 | 6 | BDIAM | 75. |
| | 6 | FDIAM | 0. |
| | 6 | BBDIAM | 3000. |
| | 6 | BFDIAM | 5. |
| | 6 | NMUN | 2 |
| | 6 | SITE | P2-08 |

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| AFATL (DL) | 1 |
| AFATL (DLGP) | 1 |
| AFATL (DLOSL) | 2 |
| AFATL (DLYW) | 10 |
| CORNELL AERO LAB (MR. EUSANIO) | 1 |
| CORNELL AERO LAB (MR. KELLER) | 1 |
| CORNELL AERO LAB (MR. WOZER) | 1 |
| HARRY DIAM LABS (AMXDO-SA/MR. ROTKIN) | 1 |
| OKLAHOMA STATE UNIVERSITY | 1 |
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| ASD (ENYS) | 1 |
| AUL (AUL-LSE-70-239) | 1 |
| HQ PACAF (IGY) | 1 |



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13. ABSTRACT

The Burst Height Distribution (BHD) Program described in this report was designed to compute and display burst height distributions for munitions aerially delivered into forest environments. The program uses as input the source and terminal X, Y, and Z coordinates and the average diameters of branches surveyed at actual forested sites, and the munitions travel along straight-line trajectories which are randomly selected. Burst heights are computed for those trajectories which encounter branches large enough to detonate the munition, and after 400 trajectories are examined (100 from each of four azimuth angles), the cumulative burst height distribution for the munition and elevation angle is computed, printed, and optionally punched as output. The computer program was specifically designed for the Control Data Corporation 6600 computer system at Eglin Air Force Base, Florida.

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| Weapons effects | | | | | | |
| Aerially delivered munitions | | | | | | |